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MILK: A REMARKABLE FOOD.

BY HENRY DWIGHT CHAPIN, M.D.

PERHAPS there is no article of diet with which every one is so familiar as milk, and about which so little is generally known. If the question, "What is there peculiar about milk as a food?" were asked, most persons would reply, "It is a liquid food furnished by Nature for young animals," and they would feel that the question had been answered properly. But to the inquiring mind there arise the questions, "Why is milk furnished by the mother?" and, "What is there about it that makes it suitable for young animals?" And the answers to these questions must be known before any intelligent idea of the properties of milk can be had.

Up to within a few years it was customary to regard anatomy and physiology as two distinct branches of knowledge, which were to be studied separately; but at last it dawned upon students that the structure of an animal, an organ or the composition of certain animal secretions is constituted to enable them to perform special functions to the best advantage, and that structure and function should always be studied together.

For many years the anatomy of milk, or its composition alone, was studied, and all that was discovered of a practical nature was that milk contains the elements needed for the formation of blood, muscle and bone, and that a portion of the milk would form curds either in the stomach or when kept long enough for it to sour.

These facts had been known for ages to practical observers who had had no special training, and really added nothing of value to the sum of human knowledge. But about four years ago it was suggested that possibly the curding of milk in the

stomach might serve a useful purpose in digestion, and the fact that milk formed curds might be one of the reasons for its being furnished to young animals. In other words, there was applied to the study of milk the principle that its composition and function should be considered together, and it is safe to say that, as a result, more has been learned about milk of practical value in infant-feeding in the last three or four years than in several centuries previous.

To-day we have an entirely different conception of milk as a food than was held by the leading authorities five years ago, and what was mysterious and unfathomable then is as clear as day now.

Almost every one knows that if a hen's egg is kept under suitable conditions for about three weeks, a fully formed and developed chick will emerge from the shell, but when a fresh egg is opened no sign of an organism is present. However, at one side of the yolk is a minute cell which contains the vital principle of the future fowl; and, strange as it may seem, this cell begins to eat the contents of the egg-shell and transforms them into tissues of the chick. This process may be watched by holding the egg to the light, when the developing of the chick may be followed from hour to hour. When the chick comes out of the shell, it is not dependent on its parent's body for food, but is capable of picking up worms and seeds and digesting them. It will be noticed that the hen supplies enough material in an egg to produce a fully formed progeny, and the chick is not started out in life with imperfectly formed organs. It will be further noticed that no young animal is independent of the mother until its digestive organs are developed.

Now, some birds when hatched are not as well developed as chicks, and the parents secure suitable food and bring it to their young as robins are often seen doing. In Australia is found the peculiar animal called the Duck Bill, which looks like a combination of a bird and an animal. This Duck Bill lays eggs with a lime shell like a bird and incubates them in a nest. When the young are hatched they are in an imperfectly developed condition, but instead of securing food for its young, as many birds do, the Duck Bill suckles them. In another form of animal, the Spiny Anteater, the egg is laid and hatched in an abdominal pouch, and the young is suckled in this pouch. With the

Kangaroo the egg is not laid at all, but is hatched inside the mother's body, and the young is then born and placed in an abdominal pouch, where it grows fast to a nipple, the mother ejecting milk or some suitable fluid into its digestive organs, until it is able to suckle, when its mouth ceases to be attached to the nipple. Soon the young animal thrusts its head out of the pouch and begins to nibble grass, and when it is capable of subsisting on such food it leaves the pouch and the milk secretion fails.

In the case of a chick, the young never derives any nourishment directly from its mother's body, all of the food needed for its development being secreted by her at one time; while in the case of a kangaroo very little of the food needed for its growth is supplied in the form of an egg, almost all being derived from the mother's nipple, a little at a time. Here is seen the highest development of the mammary function, and from the fact that the mouth of the young grows fast to the mother's nipple it will not be difficult to conclude that Nature did not intend any other food than that supplied by the mother to go into the young animal's stomach, and that no other form of food is entirely suitable.

In a hen's egg only one form of food is supplied to the developing chick, but during the period of a calf's life, before weaning, the cow supplies nourishment in at least five different forms to suit different stages of the calf's development. Milk is the last of the five special forms of food supplied by Nature for developing animals.

Structure and Function of Milk.—When milk is allowed to stand undisturbed, a layer of cream appears on the top, which is composed largely of butter or fat. When milk sours, a solid mass or curd forms; this curd is similar to lean meat in composition. A thin, watery liquid separates from the curd, and in it are dissolved a peculiar kind of sugar, a substance somewhat like white of egg, and some mineral matter. A chemical analysis of milk consists in determining the quantity of each of these component parts of milk.

The portion of the milk that forms curds serves to build blood and tissue; the mineral matter solidifies the bones, while the fat and sugar are used to supply fuel to maintain heat and the energy needed to carry on the vital processes. A chemical an-

alysis shows all foods that can support life to contain the same food elements, although they may differ markedly in appearance and taste. From a food chemist's standpoint there is no difference between a beefsteak, a pork chop and the curd of milk. Each is composed of the substance called proteid, required for tissue-building, and it is this ingredient that such a food analysis shows.

Placing too much value on a food analysis may lead to erroneous and often absurd conclusions, and it is now recognized by the leading investigators of the problems of animal nutrition that a food analysis is useful principally for showing whether or not a material contains the elementary food substances, and in what proportions. The *suitability* of the material as a food can only be determined by feeding experiments with various animals. It may suit one species and be wholly unfitted for another kind of animal. As an example of how misleading a chemical analysis by itself may be, it can be shown that a sandwich and a glass of water may have identically the same composition as a glass of milk.

It might be true that they were identical in nutritive value, but it would be absurd to conclude that therefore they were interchangeable as foods; but many similar conclusions have been drawn concerning milk which will have to be eradicated from the popular mind and also from many medical teachers' minds. A revolution among the medical profession concerning the milk question is now taking place.

There are few who do not know that pepsin is secreted by the stomach for the purpose of digesting meat and similar foods. When pepsin is added to cow's milk it does not commence to digest it, but changes it into a solid jelly. The gastric secretion of the adult is acid, like vinegar, and when this acid comes in contact with the jelly formed from the milk by pepsin, it causes a remarkable change to take place; the jelly begins to shrink and become tough and fibrous like the breast of chicken. In other words, the digestive secretions change milk into a solid food in the stomach, pepsin alone making a jelly, and pepsin and acid—the gastric secretion of the adult—changing it into a decidedly solid food.

The dessert junket is milk to which rennet, which contains pepsin, is added. Every cook knows how tough the junket be-

comes if the milk is slightly soured when used, and the toughening effect of acid can be readily shown by adding a little vinegar after the milk has "set."

Now, when most young animals are born their digestive organs are not developed, and while they are developing Nature supplies two different kinds of nourishment. Milk is not secreted by the mother until a few days after birth, another food—colostrum—being supplied at first. The first digestive secretion to appear in the stomach is pepsin, and when milk reaches the stomach it is converted into soft jelly, which is passed along into the intestines to be digested there, as pepsin does not digest food unless acid is present. As the stomach becomes stronger and begins to secrete acid as well as pepsin, the food becomes a little more solid and the stomach does more work; this increase of work continues as the stomach becomes stronger and really develops the stomach, for it has been found that young animals whose food does not furnish the suitable kind of work for the stomach do not thrive and develop, and that they suffer from obscure diseases, which are cured by furnishing the food that keeps the stomach properly occupied.

To state the matter in a few words, milk is a food peculiarly suited to the digestive organs *while they are developing*, and is so constituted that the digestive secretions can change it into a solid food, which is very soft when the digestive juices are weak, but becomes more solid as they become stronger.

Milks of Different Species.—If all young animals grew with the same degree of rapidity and all had the same kind of digestive organs, there would probably be but one kind of milk; but, as it is, there are many kinds, each peculiarly suited to the needs of the animal for which it was intended. Chemical analysis shows that animals whose growth is rapid are supplied with milk rich in tissue-building elements, while the milk supplied to animals whose growth is slower contains much less of the tissue-building food. Again, when pepsin and acid are added to the different kinds of milk, the solids formed from the milk are not alike. The milk of animals who chew their food thoroughly forms a finely divided mass, while milk supplied by animals whose stomachs are adapted for coarse, fibrous food forms a solid mass. The differences between human milk and cow's milk in this respect are very great, and few physicians to-day think

of feeding cow's milk to young infants without modifying it so that it will not form an indigestible mass in the infant's stomach. There are quite a number of ways of doing this, no one of which is suitable for every case, and the skill of the physician is often taxed to the utmost to find the one that is adapted to a given infant.

When weaning occurs, one kind of animal is capable of digesting meat, another grass, and another a mixed diet, and each of these types of animals has distinctive kinds of digestive organs which have been developed by *the mother's milk*. As the foods of the weaned animals are not interchangeable, it is not surprising that the mothers' milks are not interchangeable. It would be strange if they were.

At one time it was widely believed in the United States that cow's milk could be changed into human milk by a simple process, and this will be found taught in many medical books even to-day. But since the newer method of studying milk has been followed, it has been found that the process supposed to change cow's milk into human milk by the adding of alkalis had no such effect, but acted by preventing the action of the pepsin and acid of the stomach on the milk and throwing the milk in a fluid condition into the intestines. While it cannot be proved that this method of manipulating the food of infants has impaired their digestive capacity, the question has been raised as to whether the inability of modern infants to digest table food as early as the infants of a few years past is not due to this continuous prevention of stomach digestion. It is well worth pondering, and already there is a tendency among physicians to avoid the prevention of stomach digestion of milk by artificially fed infants as a routine practice, and to confine this practice to infants whose stomachs are disordered.

New View-point of Infant-feeding.—To-day it is believed by leading authorities that fresh cow's milk should be the basis of an artificial food for infants, not because it is more nutritive than many other foods, for it is not, but because of its being the only available nutritive material that will form a solid food of varying degrees of digestibility when acted upon by the secretions of the developing stomach. While human milk, which normally adapts itself to the infant's stomach, cannot be made from cow's milk, still, by careful watching and manipulating, the food can

be adjusted to the stomach and a well-developed digestive apparatus can be produced.

By having food contain about the same quantities of the basic food elements as are found in human milk, proper growth and nutrition are insured and a well-rounded-out child is the result.

When once the value of milk as a food for infants is appreciated, it will not be difficult to grasp the importance of a supply of good, fresh milk. It does not necessarily follow that milk six or eight hours old is really fresher and better than milk thirty-six hours old. It may be in a worse condition, for all depends upon how the milk is handled.

Milk, as it leaves the cow's udder, contains bacteria. If the cow is dirty or there is loose hay around, dust from the cow's body and the hay settles in the milk-pail, and this dust is swarming with bacteria. As soon as they reach the warm milk they commence to multiply, and in a few hours they may have increased until there are millions to the teaspoonful of milk. It is these bacteria that cause milk to sour, but most of them are not only harmless but positively beneficial. According to Professor Conn, half a teaspoonful of cream which was sour enough to be churned for butter-making contained 1,300,000,000 bacteria. If bacteria were as harmful as some imagine, no one would be alive, for who has not drunk buttermilk or eaten cottage-cheese made from sour milk which contains so many bacteria that few could grasp the numbers contained in a pint of it.

The bacteria are plants belonging to the same class as yeast and mushrooms. No one is afraid to use yeast in bread-making, or to eat mushrooms, so no one should be afraid to drink milk simply because it contains similar vegetable forms. Sometimes poisonous bacteria get into milk, but the cases of poisoning resulting are, comparatively speaking, rare, and no one need give up drinking milk on this account.

Whatever danger there may be attending the use of milk may be greatly lessened by care. If the cows and their surroundings are kept clean, the number of bacteria that get into the milk will be greatly lessened, and by cooling the milk to below forty-five degrees Fahr. and keeping it cool the multiplication of bacteria is prevented. Milk kept cool for a week may be in much better condition than milk ten hours old that has been kept at body temperature. At the Paris Exposition in 1900, milk shipped

from Illinois, New York and New Jersey was in better condition than the fresh milk of Paris a day old. All of the French milk soured the second or third day, and it was hard to convince the European experts that nothing was done to make the American milks keep except to exercise extra cleanliness in their production and subject them to low temperature, as they were not familiar with icing milk.

Pasteurization of Milk.—In Europe, milk is heated to kill the bacteria. Heating the milk to 212 degrees Fahr. (boiling it) is called sterilizing, and heating to about 170 degrees Fahr, for twenty minutes is called Pasteurizing. These processes are employed abroad largely because ice is not used to any extent. Five years ago the writer found that Paris used about 65,000 tons of ice a year, London 160,000 tons, while New York consumed about 3,000,000 tons; so it will be seen that conditions differ widely in these cities, and the arguments for Pasteurization that apply to Europe are not altogether applicable to America.

If Pasteurization made milk a perfectly safe food and had no drawbacks, it would be adopted everywhere. But it kills most of the harmless bacteria and leaves a free field to some of the worst forms, which are often killed off by the harmless kinds. This is often seen when unsweetened, canned condensed milk is used. If the can is left open in a warm place it does not sour, but putrefies and becomes like tainted meat, which is often intensely poisonous. Pasteurized milk should be kept cool, or it will soon be swarming with bacteria which are likely to be more harmful than the bacteria of unheated milk.

It is claimed by some that the germs of consumption, diphtheria, scarlet fever and typhoid fever are often carried by milk, and that these would be killed if all milk were Pasteurized. There can be no doubt that this occasionally happens, but it is known that these diseases are not spread exclusively by milk. Consumption among human beings is decreasing where the modern method of treatment is employed, and this consists of giving the patient a large number of raw eggs and several quarts of *raw milk* each day, and plenty of fresh air. If the milk were all Pasteurized and sold as at present, dipped out of cans, it could be readily reinfected by flies, dust, contaminated water and the hands of the milk-dealers; so unless the milk were put up in sealed bottles, which were kept cool until opened by the consumer, no real test of the effects

of Pasteurization could be made. All of this costs money and many will not, or cannot, pay advanced prices for milk. If they could, it would not be difficult to secure milk of undoubted wholesomeness that was produced under medical supervision, which renders Pasteurization unnecessary. The whole question of a safe milk-supply in most American cities and towns rests on a willingness to pay for the increased amount of care necessary to produce it.

It is often pointed out that the distribution of Pasteurized milk among the poor of New York City has reduced the death-rate among infants, but it should be remembered that this milk is not plain cow's milk that has been heated, but Pasteurized modified milk put up in nursing-bottles ready for use and kept on ice until distributed. Any one who has not practised medicine among the poor in the cities cannot appreciate the gross ignorance and carelessness shown in the feeding of infants, and how nearly hopeless it is to try to have food properly prepared and cared for among this class of patients, and what a boon it is to be able to have them obtain milk already prepared.

Is the high death-rate among children due entirely or largely to the milk-supply? This is a question the writer has tried hard to answer for his own satisfaction. Statistics may be a form of lies, as it is said they often are, but we all have to use them. In the portion of New York State outside of Greater New York and its suburbs, there were, according to the figures of the New York State Board of Health, 2,727 deaths from acute diarrheal disease from May 1 to November 1, 1895, most of which were among children. In Greater New York and suburbs there were 5,559 deaths from the same cause. In the year 1896 there were 3,039 deaths in the country districts, an increase of 312; and in Greater New York and suburbs 4,908, a decrease of 651 during the same period. If the milk carried the infection, and this came from the country districts, as New York imports most of its milk, and was older when used in the city and presumably in worse condition than when used in the country districts, there ought to have been a marked increase of deaths in New York City. But here is an example of increase of deaths in the country and decrease in the city from the same disease.

In other years the deaths in the city and country increase or

decrease together, or one remains stationary, while the other varies. In the summer of 1900 there were 1,015 more deaths from acute diarrheal disease in the country districts than in 1899, an increase of nearly fifty per cent., while in Greater New York and suburbs there were only 310 more deaths than in 1899, an increase of only about eight per cent. In 1901, during the same period, there were 1,304 less deaths in the country districts than in 1900, a decrease of forty-seven per cent., while in Greater New York and suburbs there were 2,248 more deaths than in 1900, an increase of fifty-eight per cent. This was the summer in which New York was torn up from one end to the other to build the subway, when sewers were opened and filth and dust were everywhere. It is well known that dust and filth are the great sources of disease, and it is certainly at least suggestive that they, and not the milk-supply, caused the great increase of death from diarrheal diseases in New York during the summer of 1900.

I have tried to give a fair statement of the facts concerning milk, looking at the subject from all standpoints, so that the reader can do some thinking on his own account and draw his own conclusions, and not be forced to choose between the opinions of different authorities scattered over the entire world where conditions are often totally different. The opinions of authorities have been known to change, and it is to be feared that there are fashions in authorities as well as in clothes.

There is one point on which all right-thinking persons will agree, and that is that the milk-supply should be above suspicion. But if the general public will not voluntarily buy the purest, cleanest milk when it is offered to them, will they vote to have laws passed compelling themselves to buy it, by forbidding the sale of any other kind of milk? The price of milk will have to go up if a cleaner milk is to be sold, for the margin of profit to the farmer now is so small that it does not obtrude itself upon his attention, and cleaner and more sanitary milk means expenditure of labor, and this costs money.

HENRY DWIGHT CHAPIN.